Application No. 09/610,094
Attorney Docket No. 13DV-13689
(07783-0038)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	CRABTREE et al.	:			
Application No.:	09/610,094	:	Group Art Unit:	2123	
Filed:	June 30, 2000	:	Examiner:	T. H. Stevens	

For: AIRCRAFT ENGINE FACE RADAR CROSS SECTION ANALYSIS

RESPONSE TO NOTIFICATION OF NON-COMPLIANT APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

A Notification of Non-Compliant Appeal Brief was mailed October 11, 2005. In the Notification, the Appeal Brief submitted on September 6, 2005 was indicated as defective for not including a Claims Appendix, an Evidence Appendix and a Related Proceedings Appendix. In response thereto, a Revised Appeal Brief is being provided herewith that incorporates the appendices identified in the Notificiation. The enclosed Revised Appeal Brief should satisfy the requirements of the Notification and 37 C.F.R. § 41.37. Appellant hereby authorizes any charges necessary for consideration of the Revised Appeal Brief to be charged to Deposit Account No. 50-1059.

Respectfully submitted,
McNEES, WALLACE & NURICK

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Dated: October 14, 2005

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	CRABTREE et al.	:		
Application No.:	09/610,094	:	Group Art Unit:	2123
Filed:	June 30, 2000	:	Examiner:	T. H. Stevens

For: AIRCRAFT ENGINE FACE RADAR CROSS SECTION ANALYSIS

REVISED APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Revised Appeal Brief is being filed within one month from a Notification of Non-Compliant Appeal Brief. The original Appeal Brief was filed on September 6, 2005, which was within two months from the Notice of Appeal submitted July 7, 2005 pursuant to 37 C.F.R. §41.37(a). This Revised Appeal Brief is being submitted in response to a Final Office Action dated March 9, 2005 and an Advisory Action dated July 1, 2005.

Appellant has previously authorized the Fee for Filing a Brief in Support of an Appeal of $500.00 and any other charges necessary for consideration of this appeal to be charged to Deposit Account No. 50-1059 with the submittal of the Appeal Brief on September 6, 2005.

1. *REAL PARTIES IN INTEREST*

The real party of interest in this pending application is General Electric Company of One River Road, Schenectady, New York, 12345, who is an Assignee of the inventors' interest, which assignment has been duly recorded in the United States Patent and Trademark Office.

2. *RELATED APPEALS AND INTERFERENCES*

Appellant, Appellant's legal representative and Assignees do not know of any directly related co-pending applications or any other appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board of Patent Appeals and Interference's decision in this pending appeal.

3. *STATUS OF CLAIMS*

Claims 1-20 are under final rejection. Claims 1-20 are being appealed. A clean copy of the appealed claims (claims 1-20) is attached hereto in the Claims Appendix.

4. *STATUS OF AMENDMENTS*

The Examiner refused entry of the proposed addition of independent claim 21 submitted by Appellant in a Response under 37 C.F.R. §1.116 dated June 9, 2005, stating that the proposed amendments are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal.

5. *SUMMARY OF CLAIMED SUBJECT MATTER*

Independent claim 1 recites a method of calculating a radar cross section of an aircraft component 200,404 having an axi-periodic structure comprising the steps of: creating a finite element model for the aircraft component 200,404 describing electromagnetic characteristics of the aircraft component 200,404 (*See e.g.*, Specification at page 2, lines 9-10 and page 5, line 6 to page 6, line 24); transforming the finite element model into a plurality of independent modes (*See e.g.*, Specification at page 2, lines 10-12 and page 6, line 25 to page 7, line 9); determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode (*See e.g.*, Specification at page 2, lines 12-17 and page 7, line 10 to page 12, line 1 and FIGs. 3A-3D and 4A-4C); summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic field for the aircraft component 200,404 (*See e.g.*, Specification at page 12, lines 1-3); and determining the radar cross section for the

aircraft component 200,404 from the total electromagnetic field (*See e.g.*, Specification at page 2, lines 17-18 and page 12, lines 5-6).

Independent claim 13 recites a computer program product embodied on a computer readable medium and executable by a computer for calculating the radar cross section (RCS) of an aircraft engine face component 200,404, the computer program product comprising computer instructions for executing the steps of: creating a finite element model for the aircraft engine face component 200,404 describing electromagnetic characteristics of the aircraft engine face component 200,404 (*See e.g.*, Specification at page 2, lines 9-10 and page 5, line 6 to page 6, line 24); transforming the finite element model into a plurality of independent modes (*See e.g.*, Specification at page 2, lines 10-12 and page 6, line 25 to page 7, line 9); determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode (*See e.g.*, Specification at page 2, lines 12-17 and page 7, line 10 to page 12, line 1 and FIGs. 3A-3D and 4A-4C); summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic far-field for the aircraft engine face component 200,404 (*See e.g.*, Specification at page 12, lines 1-5); and determining the radar cross section for the aircraft engine face component 200,404 from the total electromagnetic far-field (*See e.g.*, Specification at page 2, lines 17-18 and page 12, lines 5-6).

Independent claim 17 recites a system for calculating the radar cross section (RCS) of an aircraft engine component 200,404 comprising: a computer having memory and a processing unit (*See e.g.*, Specification at page 3, line 20 to page 4, line 10); means for creating a finite element model for the aircraft engine component 200,404 describing electromagnetic characteristics of the aircraft engine component 200,404 (*See e.g.*, Specification at page 2, lines 9-10 and page 5, line 6 to page 6, line 24); means for transforming the finite element model into a plurality of independent modes (*See e.g.*, Specification at page 2, lines 10-12 and page 6, line 25 to page 7, line 9); means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field contributed by each independent mode (*See e.g.*, Specification at page 2, lines 12-15 and page 7, line 10 to page 12, line 1 and FIGs. 3A-3D and 4A-4C); and means for summing the portion of the electromagnetic near-field

contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic near-field for the aircraft engine component 200,404 (*See e.g.*, Specification at page 12, lines 1-3); means for determining a total electromagnetic far-field for the aircraft engine component from the total electromagnetic near-field for the aircraft engine component 200,404 (*See e.g.*, Specification at page 2, lines 15-17 and page 12, lines 4-5); and means for determining the radar cross section for the aircraft engine component 200,404 from the total electromagnetic far-field (*See e.g.*, Specification at page 2, lines 17-18 and page 12, lines 5-6).

Dependent claim 3 includes said step of transforming the finite element model into a plurality of independent modes further comprises the additional steps of: assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft component 200,404 (*See e.g.*, Specification at page 5, line 6 to page 7, line 9); and applying a Discrete Fourier Transform to the system matrix (*See e.g.*, Specification at page 2, lines 10-12 and page 6, line 25 to page 7, line 9).

Dependent claim 6 includes said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of: creating a mathematical representation of a reference pipe 400 having an infinite length (*See e.g.*, Specification at page 9, lines 3-29 and FIGs. 4A-4C); and using the mathematical representation of the reference pipe 400 to determine the portion of the electromagnetic field contributed by each independent mode (*See e.g.*, Specification at page 9, line 28 to page 11, line 27 and FIGs. 4A-4C).

Dependent claim 16 includes the aircraft engine face component has an axi-periodic structure (*See e.g.*, Specification at page 5, lines 7-8) and said step of creating a finite element model for the aircraft engine face component comprises the additional step of creating a finite element model of a preselected period of the axi-periodic structure of the aircraft engine face component using second order edge elements (*See e.g.*, Specification at page 5, line 20 to page 6, line 24).

Dependent claim 18 includes the aircraft engine component has an axi-periodic structure (*See e.g.*, Specification at page 5, lines 7-8); said means for creating a finite element model for

the aircraft engine component further comprises: means for creating a finite element model of a preselected period of the axi-periodic structure of the aircraft engine component (*See e.g.*, Specification at page 5, line 20 to page 6, line 24); and said means for transforming the finite element model into a plurality of independent modes further comprises: means for assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft engine component (*See e.g.*, Specification at page 5, line 6 to page 7, line 9); and means for applying a Discrete Fourier Transform to the system matrix (*See e.g.*, Specification at page 2, lines 10-12 and page 6, line 25 to page 7, line 9).

6. *GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL*

Whether claims 1-20 are unpatentable under 35 U.S.C. § 103(a) by Barka et al. ("An Efficient Algorithm for the RCS Modulation Prediction from Jet Inlet-Engines") in view of D'Angelo et al. ("A New Finite Element Formulation for RF Scattering by Complex Bodies of Revolution" (1993)).

7. *ARGUMENT*

A. Discussion of Sole Ground of Rejection.

Ground of Rejection - Whether claims 1-20 are unpatentable under 35 U.S.C. § 103(a) by Barka et al. ("An Efficient Algorithm for the RCS Modulation Prediction from Jet Inlet-Engines") in view of D'Angelo et al. ("A New Finite Element Formulation for RF Scattering by Complex Bodies of Revolution" (1993)).

Barka et al. ("An Efficient Algorithm for the RCS Modulation Prediction from Jet Inlet-Engines"), hereafter referred to as the Barka Article, as understood, is directed to an algorithm providing the radar modulation due to a set of rotating blades computed with only one solution for any blade position. The algorithm is used with a multidomain and multimethod coupling scheme based on generalized scattering matrix computations that is suitable in a context of parametric investigations. The algorithm writes the scattering matrix in a new base using a passing matrix. The passing matrix for a rotation angle has been shown to be analytical along with the inverse for the passing matrix and both the passing matrix and its inverse has no more

than two non-zero coefficients in each row. The scattering matrix for a blade position is then determined in terms of the passing matrix and its inverse. Finally, the total number of operations that are needed to determine the scattering matrices associated with a set number of different positions of the engine blades is based on the total number of edge unknowns and the number of modal functions on the interface.

D'Angelo et al. ("A New Finite Element Formulation for RF Scattering by Complex Bodies of Revolution" (1993)), hereafter referred to as the D'Angelo Article, as understood, is directed to a design tool that provides information on scattering and radiation from complex objects that are axially symmetric. A direct three component formulation is used to solve for all three components of the electrical and magnetic fields over the domain of computation. An absorbing boundary condition is then performed directly without any interpolations to truncate the open regions surrounding the scatterer. The tool uses a final model Galerkin-finite element form for a given modal field to give the near fields inside the truncated domain. The radar cross section can be computed using a harmonic series expansion or a Green integral representation.

With regard to independent claims 1, 13 and 17, the Examiner stated:

> Barka et al. teaches using electromagnetic scattering from the interior of a complex jet engine inlet to contribute to the overall radar cross section (RCS) of a modern jet aircraft; but does not teach specific axi-symmetric aircraft related devices. D' Angelo et al. teaches solving electromagnetic scattering from complex inhomogeneous axi-symmetric bodies using finite element analysis.
>
> At the time the invention, it would have been obvious to one of ordinary skill in the art to use Barka et al. to modify D' Angelo et al. since it would be advantageous to capture the RCS from another dimension in space for a precise 3-D representation (D'Angelo: pg. 534, right column 2nd paragraph, lines 1-15 with equations 1,2).
>
> Claim 1. A method of calculating a radar cross section of an aircraft component having an axi-periodic structure comprising the steps of (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract): creating a finite element model for the aircraft component describing electromagnetic characteristics of the aircraft component (Barka: pg. 2566, Introduction); transforming the finite element model into a plurality of independent modes (Barka: pg. 2567, lines 11-12); determining, for each independent mode of the plurality of independent mode (Barka: pg. 2566, lines 19-22); a portion of an electromagnetic field contributed by each independent mode (Barka: pg. 2567, lines 11-12); summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic field for the aircraft component (D'Angelo: pg. 538, equation 21); and determining the radar cross

section for the aircraft component from the total electromagnetic field (Barka: Introduction; D'Angelo: section III, Radar Cross Section Calculation, pg.537-539). ...

Claim 13. A computer program (Barka: pg. 2567, lines 5-12) product embodied on a computer readable medium and executable by a computer for calculating the radar cross section (RCS) of an aircraft engine face component, the computer program product comprising computer instructions for executing the steps of creating a finite element model for the aircraft engine face component describing electromagnetic characteristics of the aircraft engine face component (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract); transforming the finite element model into a plurality of independent modes(Barka: pg. 2567, lines 5-12); determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode (Barka: pg. 2567, lines 18-34); summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic far-field for the aircraft engine face component (D'Angelo: pg. 537, equation 17); and determining the radar cross-section for the aircraft engine face component from the total electromagnetic far-field (D'Angelo: pg.537, equation 18). ...

Claim 17. A system for calculating the radar cross section (RCS) of an aircraft engine component comprising (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract): a computer having memory and a processing unit; means for creating a finite element model for the aircraft engine component describing electromagnetic characteristics of the aircraft engine component (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract); means for transforming the finite element model into a plurality of independent modes (Barka: pg. 2566, lines 11-18); means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field contributed by each independent mode (Barka: pg. 2566, lines 11-18 and pg. 2567, lines 21-22); and means for summing the portion of the electromagnetic near-field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic near-field for the aircraft engine component (Barka: pg. 2566, lines 11-18); means for determining a total electromagnetic far-field for the aircraft engine component from the total electromagnetic near-field for the aircraft engine component(Barka: pg. 2566, lines 11-18); and means for determining the radar cross section for the aircraft engine component from the total electromagnetic far-field (Barka: pg. 2567, lines 18-34).

In contrast, independent claim 1 recites a method of calculating a radar cross section of an aircraft component having an axi-periodic structure, independent claim 13 recites a computer program product embodied on a computer readable medium and executable by a computer for calculating the radar cross section (RCS) of an aircraft engine face component, and independent

claim 17 recites a system for calculating the radar cross section (RCS) of an aircraft engine component, each as described in greater detail above. Dependent claims 2-12, 14-16 and 18-20 recite additional subject matter and depend from independent claims 1, 13 and 17.

To begin,

> [t]o establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

See Manual of Patent Examining Procedure, 8th Edition, Revision 2 (MPEP), Section 2143.03.

Several of the features recited by Appellant in independent claims 1, 13 and 17 are not taught or suggested by the D'Angelo Article and the Barka Article. First, neither the D'Angelo Article nor the Barka Article teaches or suggests transforming the finite element model into a plurality of independent modes as recited by Appellant in independent claims 1, 13 and 17. In the D'Angelo Article, the radar cross section is calculated by using a harmonic series expansion or Green integral representation on the final model Galerkin-finite element form. In the Barka Article, the scattering matrix is to be written in a new base and is then defined in terms of a passing matrix. The Examiner alleges that the Barka Article discloses the transformation of the finite element model into a plurality of independent modes at page 2567, lines 5-12. However, this passage discusses the use of the passing matrix as described above. Appellant submits that the changing of the base of the scattering matrix with the passing matrix is not a transformation of the finite element model and furthermore, the usage of the passing matrix in the Barka Article does not result in a plurality of independent modes as recited by Appellant in independent claims 1, 13 and 17. The Examiner has been requested to explain how the changing of the base of the scattering matrix with a passing function, which results in a scattering matrix, can be considered a transformation into a plurality of independent modes, but the Examiner has not yet identified any specific passage in the Barka Article that teaches the limitations.

In the Final Office Action (in response to Appellant's prior arguments), the Examiner states that the D'Angelo Article does state that "[w]e are also investigating the use of a mixed approach where the azimuthally components of the field is expanded using node-based finite

elements and the other components" in the Conclusions section of the D'Angelo Article, and then the Examiner states that "the examiner fails to understand the distinction between 'transformation' and 'changing of the scattering matrix with the passing matrix'." First, Appellant does not understand the reference to the D'Angelo Article by the Examiner as the scattering matrix and passing matrix are discussed in the Barka Article and are not present in the D'Angelo Article. Next, in response to the Examiner's statement that he does not see a distinction between "transformation" and "changing of the scattering matrix with the passing matrix," Appellant would like to point out that Appellant's recited limitation is "transformation into a plurality of independent modes" and not just a "transformation." The Examiner has failed to identify or discuss how the changing of the scattering matrix with the passing matrix in the Barka Article results in a plurality of independent modes. As discussed above, the usage of the passing matrix in the Barka Article does not result in a plurality of independent modes as recited by Appellant in the independent claims. Thus, since the D'Angelo Article and the Barka Article do not teach or suggest all of the limitations recited in independent claims 1, 13 and 17, Appellant respectfully submits that the D'Angelo Article and the Barka Article do not render Appellant's invention as recited in independent claims 1, 13 and 17 obvious.

Furthermore, the D'Angelo Article and the Barka Article do not teach or suggest additional features recited by Appellant in independent claims 1, 13 and 17, including, determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode; and summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic field for the aircraft component. For the reasons discussed above, Appellant submits that the D'Angelo Article and the Barka Article do not teach or suggest these features as they do not teach or suggest a plurality of independent modes. Furthermore, Appellant would like to point out that the Examiner has alleged that the Barka Article teaches the transformation into the plurality of independent modes and the determination of the electromagnetic field for each independent mode, but then alleges that the D'Angelo Article teaches the summing of an electromagnetic field for each independent mode. Appellant submits that the D'Angelo Article cannot teach or suggest this limitation as the D'Angelo Article

does not teach or suggest an independent mode as acknowledged by the Examiner in the outstanding office action by referring to the Barka Article.

The Examiner has stated in the Final Office Action (in response to Appellant's prior arguments) that the D'Angelo Article teaches at Equation 3 the determining of portions of an electromagnetic field and at Equation 7 the summing of the portion of the electromagnetic field contribution. In response, Appellant would like to point out that Equation 3 in the D'Angelo Article refers to the incident magnetic field and not an electromagnetic field (*See*, D'Angelo at page 535, left-hand column lines 5-6). Furthermore, Equation 3 in the D'Angelo Article does not include the scattering matrix from the Barka Article, which the Examiner has stated includes the plurality of independent modes and to which Appellant disagreed with the Examiner. Also, it is pointed out that Equation 7 in the D'Angelo Article is 1) not summing the incident magnetic field from Equation 3 in the D'Angelo Article, but in fact performing a decomposition of the scattered magnetic field into azimuthal modes (*See*, D'Angelo at page 535, left-hand column lines 23-25) and 2) not directed to an electromagnetic field as recited by Appellant. Thus, since the D'Angelo Article and the Barka Article do not teach or suggest all of the limitations recited in independent claims 1, 13 and 17, Appellant respectfully submits that the D'Angelo Article and the Barka Article do not render Appellant's invention as recited in independent claims 1, 13 and 17 obvious.

Next, Appellant respectfully submits that the Examiner has improperly combined the D'Angelo Article and the Barka Article. The Examiner has provided no teaching or suggestion in the D'Angelo Article that would indicate the desirability of incorporating into the D'Angelo Article the modulation algorithm of the Barka Article, nor has the Examiner cited any passage in the Barka Article that would indicate that the modulation algorithm can be used in the finite element formulation of the D'Angelo Article. The Examiner has only made a conclusory statement that it would be "obvious to one of ordinary skill in the art to use Barka et al. to modify D' Angelo et al. since it would be advantageous to capture the RCS from another dimension [in] space for an precise 3-D representation." Further, the Examiner has repeated this conclusory statement in the Final Office Action and apparently added a different motivation to combine the D'Angelo Article and the Barka Article (in response to Appellant's prior arguments) that relates to the determination of a radar cross section analysis by stating that

> [t]he Barka reference discloses but does not expound the teaching of modeling a jet inlet component by way of a radar cross section in the 3-D (Barka: pg 2556 lines 13-15) whereas D'Angelo does for example page 537, section 3 RADAR CROSS SECTION CALCULATION. Furthermore, MPEP 2143.01 states that one of the possible sources of motivation, is the teaching of the prior art. Combining or modifying the teachings of the prior art to produce the claimed invention can only establish obviousness.

While it is unclear to Appellant what point the Examiner was trying to make with the above passage, it appears that the Examiner is stating that the Barka Article and the D'Angelo Article can be combined because they both relate to radar cross section calculation. However,

> Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention <u>where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art</u>. [emphasis added]

See, MPEP Section 2143.01

In this case, the fact that the D'Angelo Article and the Barka Article may be in the same field of endeavor is not, by itself, a teaching or suggestion that the techniques and features of the D'Angelo Article can be combined with the techniques and features of the Barka Article. The Examiner has not provided any teaching, suggestion or motivation in either the D'Angelo Article or the Barka Article that it would be "obvious to one of ordinary skill in the art to use Barka et al. to modify D' Angelo et al. since it would be advantageous to capture the RCS from another dimension [in] space for an precise 3-D representation." Appellant respectfully submits that the Examiner has reached his conclusion regarding the combination of the Barka Article and the D'Angelo Article based on the teachings in Appellant's specification, which is impermissible hindsight reasoning by the Examiner.

> In making the assessment of differences, section 103 specifically requires consideration of the claimed invention "as a whole." Inventions typically are new combinations of existing principles or features. *Envtl. Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 698 <u>[218 USPQ 865]</u> (Fed. Cir. 1983) (noting that "virtually all [inventions] are combinations of old elements."). The "as a whole" instruction in title 35 prevents evaluation of the invention part by part. Without this important requirement, an obviousness assessment might break an invention into its component parts (A + B + C), then find a prior art reference containing A, another containing B, and another containing C, and on that basis alone declare the invention obvious. This form of hindsight reasoning, using the invention as a roadmap to find its prior art components, would discount the value of combining

> various existing features or principles in a new way to achieve a new result – often the very definition of invention.
>
> Section 103 precludes this hindsight discounting of the value of new combinations by requiring assessment of the invention as a whole. This court has provided further assurance of an "as a whole" assessment of the invention under §103 by requiring a showing that an artisan of ordinary skill in the art at the time of invention, confronted by the same problems as the inventor and with no knowledge of the claimed invention, would select the various elements from the prior art and combine them in the claimed manner. In other words, the examiner or court must show some suggestion or motivation, before the invention itself, to make the new combination. See In re Rouffet, 149 F.3d 1350, 1355-56 [47 USPQ2d 1453] (Fed. Cir. 1998).

Ruiz v. A.B. Chance Co., 357 F.3d 1270, 1276, 69 USPQ2d 1686, 1690 (Fed. Cir. 2004)

Appellant submits that the Examiner has impermissibly used Appellant's invention to find its components in the prior art. In the Final Office Action, the Examiner appears to pick and choose features from either the D'Angelo Article or the Barka Article to address particular features recited by Appellant in the claims without any further explanation. This is shown in the Examiner's reasoning regarding the independent modes discussed above, wherein the Barka Article is alleged to teach features relating to the independent modes and then suddenly, the D'Angelo Article is alleged to teach features relating to the independent modes.

Furthermore, "[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art suggests the desirability of the combination." *See* MPEP, Section 2143.01.

In this case, the D'Angelo Article explicitly teaches away from the advantage cited by the Examiner in the Office Action. The D'Angelo Article states in the Abstract that the "finite element mesh is truncated using a three-dimensional vector absorbing boundary condition." Thus, it appears to be clear that the the D'Angelo Article is already a precise 3-D representation, and if it is simplified to 2-D, it is simplified on purpose (*See*, the D'Angelo Article, page 535, right-hand column), therefore, there appears to be no need for the advantage proposed by the Examiner because the D'Angelo Article is already a 3-D representation. "If the proposed modification or combination of the prior art would change the principle or operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." *See* MPEP, Section 2143.01.

Therefore, for the reasons given above, independent claims 1, 13 and 17 are believed to be distinguishable from the D'Angelo Article and the Barka Article and therefore are not anticipated nor rendered obvious by the Barka Article.

Dependent claims 2-12, 14-16 and 18-20 are believed to be allowable as depending from what are believed to be allowable independent claims 1, 13 and 17 for the reasons given above. In addition, claims 2-12, 14-16 and 18-20 recite further limitations that distinguish over the applied art.

For example, claim 3 recites a Discrete Fourier Transform, which is clearly not taught or suggested by either the D'Angelo Article or the Barka Article. The Examiner has stated in the Final Office Action (in response to Appellant's prior arguments) that "Equation 7 of D'Angelo is an example of an indefinite Fourier Transform with limits or boundary conditions, thus becoming a discrete Fourier transform (i.e., equation 9 D'Angelo)." In response to the Examiner's statements, Appellant cannot determine any relationship between equations 7 and 9 in the D'Angelo Article as set forth by the Examiner and thus, submits there is no Discrete Fourier Transform as recited by Appellant in claim 3. Equation 7 in the D'Angelo Article is a decomposition of the scattered magnetic field into azimuthal modes (*See*, the D'Angelo Article at page 535, left-hand column lines 23-25) and Equation 9 in the D'Angelo Article is a family of absorbing boundary conditions based on the Wilcox expansion theorem. *See*, the D'Angelo Article, page 535. The Examiner is requested to identify the specific passage(s) in the D'Angelo Article that link Equations 7 and 9. It is also noted that the Examiner has stated that Equation 7 of the D'Angelo article also allegedly teaches summing the portion of the magnetic field contribution. *See* Final Office Action, pages 2-3. Finally, the Examiner attempts to show the teaching of a Discrete Fourier Transform in the Abstract of the D'Angelo Article by reference to Appellant's Specification. *See* Final Office Action, page 3. Based on this language and reasoning it appears that the Examiner has reached his conclusion based on the teachings in Appellant's specification, which is impermissible hindsight reasoning by the Examiner.

Claim 6, recites creating a mathematical representation of a reference pipe having an infinite length and using the mathematical representation of the reference pipe to determine the portion of the electromagnetic field contributed by each independent mode, which limitations are clearly not taught or suggested by either the D'Angelo Article or the Barka Article. The

Examiner alleges that these limitations are taught by the D'Angelo Article at page 540, lines 8-31 and at pages 539-540, Results and Discussion. However, the passage(s) identified in the D'Angelo article by the Examiner relates to the validation of the code by considering several different geometries, including "a finite circular cylinder." Thus, there is nothing in D'Angelo that teaches the creation of a mathematical representation of **a reference pipe having an infinite length** as recited by Appellant in claim 6 (emphasis added). The Examiner is asked to specifically identify where in D'Angelo a reference pipe having an infinite length is taught or suggested. Furthermore, since D'Angelo does not teach or suggest a reference pipe having an infinite length, D'Angelo cannot teach or suggest using the reference pipe to determine the portion of the electromagnetic field contributed by each independent mode as also recited by Appellant in claim 6.

To further elaborate, the reference pipe having an infinite length or "infinite pipe" is used to model the termination of the cavity. Here, the "infinite pipe" provides a reflection-less boundary condition to the finite element modeling of the electromagnetic fields within a propulsion cavity. This boundary condition is used for accurately determining the low field returns found in a low observable propulsion system. *See e.g.,* Appellant's Specification, page 9, lines 3-10.

It is also noted that claims 1, 16 and 18 recite that the aircraft component has an axi-periodic structure. The axi-periodic structure is a discrete rotationally periodic structure - i.e., an object which geometrically repeats itself in the azimuthal direction. *See e.g.,* Appellant's Specification, page 5, lines 6-16. This feature is not taught or suggested by the D'Angelo Article or the Barka Article. The D'Angelo article teaches and demonstrates the modal decomposition of a rotationally symmetric structure (a body of revolution). The Barka Article uses modal decomposition of a cavity's cross-section in the transverse direction to the depth of the cavity. The Barka Article then models the cavity as a whole by coupling multiple modal decompositions taken at various cross-section stages. Neither the D'Angelo Article nor the Barka Article have relevance to this Application.

In conclusion, it is respectfully submitted that claims 1-20 are not anticipated nor rendered obvious by the D'Angelo Article and the Barka Article and are therefore allowable.

B. Conclusion

In view of the above, Appellant respectfully requests a favorable action on this pending Appeal and withdrawal of the outstanding rejections. As a result of the remarks presented herein, Appellant respectfully submits that claims 1-20 are not anticipated by, nor rendered obvious by the Barka Article, the D'Angelo Article or their combination and thus, are in condition for allowance.

Respectfully submitted,
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Attachments (Claims Appendix, Evidence Appendix, and Related Proceedings Appendix)

8. *CLAIMS APPENDIX*

Clean Copy of Appealed Claims

1. A method of calculating a radar cross section of an aircraft component having an axi-periodic structure comprising the steps of:

   creating a finite element model for the aircraft component describing electromagnetic characteristics of the aircraft component;

   transforming the finite element model into a plurality of independent modes;

   determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode;

   summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic field for the aircraft component; and

   determining the radar cross section for the aircraft component from the total electromagnetic field.

2. The method of claim 1 wherein said step of creating a finite element model for the aircraft component further comprises the step of creating a finite element model of a preselected period of the axi-periodic structure of the aircraft component.

3. The method of claim 2 wherein said step of transforming the finite element model into a plurality of independent modes further comprises the additional steps of:

   assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft component; and

   applying a Discrete Fourier Transform to the system matrix.

4. The method of claim 1 wherein said step of creating a finite element model for the aircraft component further comprises the step of creating the finite element model using second order edge elements.

5. The method of claim 4 wherein the second order edge elements are curl conforming type elements.

6. The method of claim 1 wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

creating a mathematical representation of a reference pipe having an infinite length; and

using the mathematical representation of the reference pipe to determine the portion of the electromagnetic field contributed by each independent mode.

7. The method of claim 6 wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

creating a mathematical representation of a test fixture;

creating a mathematical representation of the aircraft component in a cavity;

coupling the mathematical representation of the test fixture to the mathematical representation of the aircraft component to create a mathematical representation of a combination of the test fixture and the aircraft component;

coupling the mathematical representation of the reference pipe to the mathematical representation of the combination of the test fixture and the aircraft component to create a mathematical representation of the reference pipe, the test fixture and the aircraft component having a common interface between the test fixture and the reference pipe; and

solving the mathematical representation of the reference pipe, the test fixture and the aircraft component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe.

8. The method of claim 7 wherein said step of creating a mathematical representation of a test fixture further comprises the additional steps of:

creating a single layer of finite elements describing electromagnetic characteristics of the test fixture;

assembling a system matrix for the single layer of finite elements;

factoring the system matrix for the single layer of finite elements into a test fixture impedance matrix, wherein the test fixture impedance matrix represents end surfaces of the test fixture having a length; and

doubling the length of the test fixture represented by the test fixture impedance matrix until a preselected length of test fixture is represented by the test fixture impedance matrix.

9. The method of claim 8 wherein said step of creating a mathematical representation of a reference pipe having an infinite length further comprises the additional steps of:

copying the test fixture impedance matrix representing the test fixture of the preselected length to create a reference pipe impedance matrix, wherein the reference pipe impedance matrix represents end surfaces of the reference pipe having the preselected length; and

doubling the length of the reference pipe represented by the reference pipe impedance matrix until a length of reference pipe is represented wherein the end surfaces of the reference pipe are uncoupled.

10. The method of claim 7 wherein the mathematical representation of the test fixture, the mathematical representation of the reference pipe and the mathematical representation of the aircraft component are each a super-element and the method further comprises the steps of :

storing the super-elements for the test fixture, reference pipe and aircraft component in memory;

modifying the aircraft component; and

reusing stored super-elements for the test fixture and reference pipe to calculate a radar cross section for the modified aircraft component.

11. The method of claim 7 wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

coupling the mathematical representation of the reference pipe to another identical mathematical representation of the reference pipe to create a mathematical representation of a two-sided reference pipe having a common interface;

solving the mathematical representation of the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes; and

determining the difference between the solution of the representation of the reference pipe, test fixture and aircraft component and the solution of the representation of the two-sided reference pipe.

12. The method of claim 1 wherein the plurality of independent modes comprises primary modes and conjugate modes related to the primary modes and said step of determining, for each independent mode of the plurality of independent modes, the portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of:

determining an impedance matrix for each primary mode of the plurality independent modes; and

determining an impedance matrix for each conjugate mode by transposing the impedance matrix of the corresponding primary mode for each conjugate mode.

13. A computer program product embodied on a computer readable medium and executable by a computer for calculating the radar cross section (RCS) of an aircraft engine face component, the computer program product comprising computer instructions for executing the steps of:

creating a finite element model for the aircraft engine face component describing electromagnetic characteristics of the aircraft engine face component;

transforming the finite element model into a plurality of independent modes;

determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode;

summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic far-field for the aircraft engine face component; and

determining the radar cross section for the aircraft engine face component from the total electromagnetic far-field.

14. The computer program product of claim 13 wherein the step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

creating a mathematical representation of a test fixture;

creating a mathematical representation of the aircraft engine face component in a cavity;

creating a mathematical representation of a reference pipe having an infinite length;

coupling the mathematical representation of the test fixture to the mathematical representation of the aircraft engine face component to create a mathematical representation of the combination of the test fixture and the aircraft engine face component;

coupling the mathematical representation of the reference pipe to the mathematical representation of the combination of the test fixture and the aircraft engine face component to create a mathematical representation of the reference pipe, the test fixture and the aircraft component having a common interface between the test fixture and the reference pipe; and

solving the mathematical representation of the reference pipe, the test fixture and the aircraft engine face component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe.

15. The computer program product of claim 14 wherein the step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of:

coupling the mathematical representation of the reference pipe to another identical mathematical representation of the reference pipe to create a mathematical representation of a two-sided reference pipe having a common interface;

solving the mathematical representation of the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes; and

determining the difference between the solution of the representation of the reference pipe, test fixture and aircraft engine face component and the solution of the representation of the two-sided reference pipe.

16. The computer program product of claim 13 wherein the aircraft engine face component has an axi-periodic structure and said step of creating a finite element model for the aircraft engine face component comprises the additional step of creating a finite element model of a preselected period of the axi-periodic structure of the aircraft engine face component using second order edge elements.

17. A system for calculating the radar cross section (RCS) of an aircraft engine component comprising:

a computer having memory and a processing unit;

means for creating a finite element model for the aircraft engine component describing electromagnetic characteristics of the aircraft engine component;

means for transforming the finite element model into a plurality of independent modes;

means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field contributed by each independent mode; and

means for summing the portion of the electromagnetic near-field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic near-field for the aircraft engine component;

means for determining a total electromagnetic far-field for the aircraft engine component from the total electromagnetic near-field for the aircraft engine component; and

means for determining the radar cross section for the aircraft engine component from the total electromagnetic far-field.

18. The system of claim 17 wherein:

the aircraft engine component has an axi-periodic structure;

said means for creating a finite element model for the aircraft engine component further comprises:

means for creating a finite element model of a preselected period of the axi-periodic structure of the aircraft engine component; and

said means for transforming the finite element model into a plurality of independent modes further comprises:

means for assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft engine component; and

means for applying a Discrete Fourier Transform to the system matrix.

19. The system of claim 17 wherein said means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field contributed by each independent mode comprises:

means for creating an impedance matrix for a test fixture;

means for creating an impedance matrix for the aircraft engine component in a cavity;

means for creating an impedance matrix for a reference pipe having an infinite length;

means for coupling the impedance matrix for the test fixture to the impedance matrix for the aircraft engine component to create an impedance matrix for the combination of the test fixture and the aircraft engine component;

means for coupling the impedance matrix for the reference pipe to the impedance matrix for the combination of the test fixture and the aircraft component to create an impedance matrix for the reference pipe, the test fixture and the aircraft engine component having a common interface between the test fixture and the reference pipe; and

means for solving the impedance matrix for the reference pipe, the test fixture and the aircraft engine component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe.

20. The system of claim 17 wherein said means for determining, for each independent mode of the plurality of independent modes, a portion of a electromagnetic near-field contributed by each independent mode further comprises:

means for coupling the impedance matrix for the reference pipe to another identical impedance matrix for the reference pipe to create an impedance matrix for a two-sided reference pipe having a common interface;

means for solving the impedance matrix for the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes; and

means for determining the difference between the solution of the impedance matrix for the reference pipe, test fixture and aircraft engine component and the solution of the impedance matrix for the two-sided reference pipe.

9. *EVIDENCE APPENDIX*

None.

10. *RELATED PROCEEDINGS APPENDIX*

None.

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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

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